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Public Health Reports.

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UNITED STATES.

BACTERIOLOGICAL STUDY OF THE WATER SUPPLY OF SAN FRANCISCO, CAL.

SAN FRANCISCO, CAL., *November 6, 1895.*

SIR: The United States is interested in the general health of every portion of its vast domain, and the question of the supply of pure water has especial weight in a great seaport like San Francisco.

There have been questions raised about the purity of the supply of water of San Francisco, and you would add to the knowledge of the United States Government, and to that of our own citizens, if you would have a bacteriological and chemical analysis made of the sources of the water of this city.

In a conversation with Dr. John Godfrey, surgeon in charge of the United States marine hospital (at San Francisco), this question came up, and he said that a request from me, as mayor of the city, to the Surgeon-General of the United States Marine-Hospital Service might have the effect of authorizing Dr. M. J. Rosenau, who I am informed is competent and now present here, to make such an examination.

With high regards, I am, ADOLPH SUTRO, *Mayor.*

To the SURGEON-GENERAL OF THE
UNITED STATES MARINE-HOSPITAL SERVICE.

WASHINGTON, D. C., *November 23, 1895.*

SIR: In reply to your letter requesting that Passed Assistant Surgeon Rosenau be detailed to make a bacteriologic and chemic analysis of the water supply of your city, I have to state that it gives me great pleasure to grant your request. Passed Assistant Surgeon Rosenau has been instructed to commence at once a systematic bacteriological examination of the water supply, and on the completion of his work to make a full report thereon.

Respectfully, yours, WALTER WYMAN,
Supervising Surgeon-General U. S. M. H. S.

Hon. ADOLPH SUTRO, *Mayor of San Francisco, Cal.*

WASHINGTON, D. C., *November 23, 1895.*

Passed Assistant Surgeon M. J. ROSENAU, U. S. M. H. S., *San Francisco Quarantine, Angel Island, Cal.* (Through medical officer in command.)

SIR: * * * I have to inform you that Hon. Adolph Sutro, mayor of San Francisco, has requested that a chemic and bacteriologic examination be made of the water supply of San Francisco by the Marine-Hospital Service. I have to inform you that you have been detailed for this duty. You will, so far as your duties at quarantine permit, make thorough bacteriologic examination of the general water supply of the city. It is not deemed necessary for you to make an examination of private wells—only those which furnish a public supply. It is not practicable for a chemic examination to be undertaken. The necessary apparatus and culture media have been sent you

On completion of your examination you will make a full report to the Bureau.

Respectfully, yours,
WALTER WYMAN,
Supervising Surgeon-General U. S. M. H. S.

In accordance with the above correspondence, the following report has been prepared by Passed Assistant Surgeon M. J. Rosenau, U. S. M. H. S.:

SOURCES OF SUPPLY AND DISTRIBUTION.

The Spring Valley Water Company furnishes San Francisco most of its water. Its principal source is from three catch basins, made by damming conveniently shaped valleys, between 12 and 20 miles from the city, in San Mateo County. These three reservoirs are known, respectively, as Crystal Springs, San Andreas, and Pilarcitos. From each a pipe line leads to the city, thus making three water districts. These districts are irregularly shaped and discontinuous, owing to engineering difficulties. These three systems are connected in such a manner that the water from any one reservoir may be pumped to either of the other two districts. This fact negatives the importance of regarding the districts as separate—from a sanitary standpoint. Smaller reservoirs in the city are used more for the purpose of storage, in case of sudden increased demand by fire, or from accident, than for obtaining pressure. The flow is continuous.

The Visitacion Water Company supplies about 600 consumers in the southern section of the city. The source of this water is from 8 wells, sunk in Bay View Valley, on the outskirts of the city. Six of these wells are 150 feet deep, 1 is 180, the other 130 feet through sand and gravel. The wells do not flow spontaneously, and are fitted with deep-well pumps. They are known as artesian wells, but as they do not pass through an impervious stratum they do not comply with the original meaning of that term.

Wells.—From the best information at my command there are very few private wells for drinking and household purposes in the city.

METHODS.

Collecting.—It was the purpose at first to obtain samples from the head waters and reservoirs and follow them down. This being inexpedient the plan was abandoned, and the samples were, for the most part, taken from the water as it flowed from the taps in houses. All samples were collected by myself, with due precautions. Special care was exercised to select a tap that led directly from the main. This was always a matter of concern, for many of the houses in San Francisco have cisterns on the roofs, for the purpose of lessening the pressure, thus cheapening plumbing. Some of these tanks are open, affording a lodging place for flying particles, bird excrement, and other refuse. Even the closed ones are a nuisance and false economy. In all cases the tap was allowed to flow sufficiently long to clear the pipe before the sample was taken.

Qualitative examination.—For isolating fermentative organisms the method of Theobald Smith was found a great help.* About 5 cubic centimeters of the suspected water is planted in a fermentation tube, containing milk sugar, or grape sugar bouillon, and grown at 41.5°-42° C. for forty-eight hours. If fermentation occurs the growth thus obtained is planted upon milk sugar or grape sugar agar and grown at 37° C. for twenty-four to forty-eight hours, at the end of which time red colonies usually make their appearance. These red colonies are transplanted to blue litmus milk, and in case they cause coagulation are further studied for their morphological and biological characters. In several instances the colon bacillus was isolated by planting 0.5 cubic centimeters of the suspected water directly upon Wurtz milk sugar litmus agar and growing the plants at 41.5°-42° C. This slight modification of Smith's method has proven useful, not only for isolating suspicious organisms, but it is believed that it may be used to give a proximate idea of their number to the cubic centimeter. In case the above methods failed to find fermenting organisms, the water was further studied upon gelatine and glycerine agar, with the result that in 7 samples 8 suspicious organisms were found. These all proved to be forms belonging to the group of proteus and resembling Proteus vulgaris. They all grow well at room temperature, also at 37°, but not at 41.5° C.

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*For this method, as well as for other valuable suggestions, I am indebted to Passed Assistant Surgeon J. J. Kinyoun, U. S. M. H. S.

Quantitative examination.—The counting of the colonies was done immediately upon returning to the laboratory, and without delay. The counting was done in the usual manner in gelatine, by adding a measured amount of the water to each Petri dish. The average of 3 plates was taken as the result. The multiplication of Proteus colonies and the liquefaction of the gelatine in several instances spoiled the counts, a disadvantage of this medium over agar for this purpose.

SUMMARY AND CONCLUSIONS.

Thirty-six samples of the city's water were examined. They were collected from widely separated points, between December 4, 1895, and February 7, 1896. Fermenting organisms were isolated from 14 of the 36 samples; 8 of these 14 contained proteus, and the remaining 6 the colon bacillus. In all, 26 organisms were studied, and are recorded in detail. The frequent presence of fluorescing bacteria (in particular bacillus fluorescens liquefaciens), and the occasional appearance of the commoner mold fungi indicate the surface character of the water. In the San Andreas water both the colon bacillus and proteus were found. In the Pilarcitos water, also, both proteus and the colon organisms were isolated. In the Crystal Springs water only an occasional proteus was met with. That is, in only 2 samples of 17 examined were suspicious organisms isolated. The greater freedom from fermenting organisms enjoyed by this water is in accord with the control of the watershed, and indicates what may be accomplished in preventing contamination of the water, by excluding all habitation from the water basin. The Visitacion water was found to contain the colon bacillus.

Significance of the Proteus group.—The presence of proteus indicates fermenting processes, doubtless the decomposition of organic matter in the water. This organism is one of the most common and widely distributed putrefactive bacteria. Proteus was found in the samples from Crystal Springs, San Andreas, and Pilarcitos waters.

Significance of the Colon group.—The colon bacillus is an intestinal organism, and its presence in the water means contamination with alvine discharges—either of man or the lower animals. Concerning its meaning, I can not do better than quote Abbott:

"In the normal intestinal tract of all human beings and many other mammals, as well as associated with the specific disease producing bacterium in the intestines of typhoid fever patients, is an organism that is frequently found in polluted drinking waters, and whose presence is proof positive of pollution by either normal or diseased intestinal contents; and though efforts may result in failure to detect the specific bacillus of typhoid fever, the finding of the other organism, the bacterium coli commune, justifies one in expressing the opinion that the water under consideration has been polluted by intestinal evacuations from either human beings or animals. Waters so located as to be liable to such pollution can never be considered as other than a continuous source of danger to those using them."

This organism was found in samples from San Andreas, Pilarcitos, and Visitacion.

The fact that the colon bacillus was more readily isolated from the water after the heavy rains * and that fermentation at 41.5°-42° C. was also more frequent after the heavy rains than before would indicate soil washings as one of the sources of this organism in the water; but that its presence in the water is not alone the result of soil washings of pasture lands is indicated by a study of the typhoid fever records. Typhoid fever is a constant factor in San Francisco, as will be seen from Table I (*vide infra*); and, further, a study of the death rate † from this disease to rainfall shows a striking coincidence in several years, i. e., a marked rise in deaths following the first heavy rains. (See Table II.)

It is reasonable to suppose that the greater freedom from biological impurities of the Crystal Springs water is due to the control of the watershed. If this is also practicable in the case of the San Andreas and Pilarcitos water basins, their control would accomplish much toward purer water. If control of the watersheds is not practicable, attention is again called to the value of central sand filtration. A method which has proven itself of great practical value at Altona, Prussia, during the recent cholera epidemic, and later at Hamburg, where, since the installation of filtering beds, there has been a marked decrease in the number of cases and deaths from intestinal diseases, such as typhoid fever, diarrhea, and gastroenteritis.

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*8.14 inches of rain fell in sixteen days—January 13-28, 1896.

†Only the deaths, and not the number of cases, are recorded.

The work in detail follows:

SAN ANDREAS WATER.

(College Hill District.)

In 6 samples of water from the San Andreas District fermenting organisms were isolated from three. Both proteus and the colon bacillus were found, the latter before and after the heavy rains.

SAMPLE No. I (December 12, 1895. From College Hill reservoir).—Ninety-five colonies to the cubic centimeter. Ferments milk-sugar bouillon 41.5°–42° C.

Bacillus a (belonging to the Proteus group. From gelatine).—A short rod, single, and in pairs and short chains; actively motile; grows well at room temperature and at 37° C., but not at 41.5° C.; liquefies gelatine slowly all along stab, with a zone of cloudiness near the surface and whitish precipitate at bottom; young colonies upon gelatine are pale and finely granular, become more irregular, darker, brownish yellow, soon liquefying and spreading with amœba-like processes; the bouillon causes a uniform cloudiness; cultures in gelatine and bouillon have a putrefactive odor and alkaline reaction; coagulates blue litmus milk with acid reaction in four days; upon potato grows as a yellowish, raised, moist membrane; trace of indol; causes fermentation in milk-sugar bouillon (2 per cent) with alkaline reaction; no CO_2, no H; on grape-sugar bouillon (1 per cent) causes fermentation with acid reaction; gas not determined.

Bacillus b (belonging to the Colon group. Red colony).—A short rod, with rounded ends, single, in pairs, and short chains; motile but not active; grows at 41.5°–42° C.; does not liquefy gelatine; colonies upon gelatine plate are variable; small ones are hyaline and spherical, the older ones are finely granular, irregular in outline, some spindle shaped, and a few concentrically striated; pale yellowish in color and darker in the center; causes bubbles in gelatine shake culture; grows in decidedly acid bouillon, producing a uniform cloudiness; no indol; upon potato produces a moist, thin, shining, scarcely visible layer; coagulates blue milk in seven days; acid reaction; ferments both milk sugar and grape sugar bouillon, producing an acid reaction, and CO_2 and H.

Bacillus c (belonging to the Colon group. Red colony).—A short bacillus, with rounded ends, exhibiting slight motility; mostly in pairs; does not liquefy gelatine; upon gelatine plates, young colonies are spherical, homogeneous, and refractive; older ones become darker, granular, with paler zone about periphery, and irregular in outline; causes bubbles in gelatine shake culture; grows at 41.5°–42° C., also in decidedly acid bouillon; in alkaline bouillon it causes uniform cloudiness and acid reaction; no indol; coagulates blue litmus milk with acid reaction in seven days; upon potato produces a moist, scanty, glazed layer; ferments milk-sugar bouillon, with acid reaction, and produces CO_2 and H; ferments grape-sugar bouillon, with acid reaction; no CO_2, no H.

Bacillus d (belongs to the Colon group. Red colony).—A short rod, with rounded ends; single, in pairs, and short rods; actively motile; does not liquefy gelatine; in gelatine plates colonies are hyaline and spherical, becoming granular, yellowish, darker in center, irregular in outline, some whetstone, and some marked in concentric zones. In gelatine shake culture causes bubbles; grows at 41.5° C., and in decidedly acid bouillon; uniform cloudiness in bouillon and decided odor; no indol; upon potato a moist, thin layer; coagulates blue milk in six days, with pink color; ferments 1 per cent grape-sugar bouillon, with acid reaction and production of H, but no CO_2; ferments 2 per cent milk-sugar bouillon, with acid reaction and production of both CO_2 and H.

Bacillus e (belongs to the Colon group. Red colony).—A short bacillus with rounded ends; single, in pairs, and short rods; motile, but not active; does not liquefy gelatine; causes bubbles in gelatine shake cultures and in gelatine stab cultures; colonies in gelatine plates are hyaline and spherical, becoming granular and irregular in outline; grows at 41.5°–42° C., and also in decidedly acid media; in bouillon causes a diffused cloudiness and acid reaction; upon potato, grows as a moist, scanty, grayish layer; blue litmus milk is coagulated, with acid reaction in eight days; ferments grape-sugar bouillon, with acid reaction; no CO_2; no H.

Bacillus f (belongs to the Colon group. Red colony).—A short bacillus, with rounded ends; single, in pairs, and short rods; slight motility; does not liquefy gelatine; colonies in gelatine are hyaline and round; larger ones are granular, irregular, darker in center; distinct edge; causes bubbles in gelatine shake cultures; grows at 41.5° C. and in decidedly acid bouillon; in alkaline bouillon causes a diffused cloudiness and acid reaction; upon potato produces a moist, scarcely visible layer; blue litmus milk is coagulated and turned acid in eight days; no indol; ferments milk-sugar bouillon, with acid reaction, and production of CO_2 and H.

SAMPLE No. II (December 21, 1895. From tap at northwest corner Ellis and Jones streets. College Hill District).—Eighty-one colonies to the cubic centimeter. Not studied further.

Sample No. III (January 8, 1896. From tap at 517 Jones street. College Hill District).—Eight hundred and sixty colonies to the cubic centimeter. Does not ferment grape-sugar bouillon at 41.5°–42° C.

Sample No. IV (January 15, 1896. From tap at 124 Turk street. College Hill District).—720 colonies to the cubic centimeter. Does not ferment milk sugar or grape sugar bouillon at 41.5°–42° C.

Sample No. V (January 29, 1896. From tap at 115 Jones street. College Hill District).

Bacillus g (belongs to the Colon group. Red colony).—A short rod, with rounded ends, mostly in pairs; a few short chains; motile, but not active; does not liquefy gelatine; colonies upon gelatine plate are yellowish brown, coarsely granular, and broken-glass appearance; young colonies are rounded, larger, are irregular in outline, and some have wavy striations; causes bubbles in gelatine shake cultures; grows in decidedly acid media; diffused cloudiness in bouillon; no odor; upon potatoes a moist, grayish white, elevated layer; coagulates and turns blue litmus milk pink in four days; no indol; ferments grape-sugar bouillon, with acid reaction and production of CO_2 and H; ferments grape-sugar bouillon, with acid reaction, but gas does not respond to tests for CO_2 or H.

Sample No. VI (January 29, 1896. From tap at 324 Grant avenue. College Hill District).—Four hundred and forty colonies to the cubic centimeter. Ferments grape-sugar bouillon at 41.5°–42° C.; does not ferment milk-sugar bouillon at the same temperature.

Bacillus h (belongs to the Colon group. Red colony).—A short rod, with rounded ends; mostly in pairs; a few short chains; very slight motility; does not liquefy gelatine; colonies in gelatine; deeper colonies are brownish, granular, darker in center, and irregular in outline; some spindle shaped; surface colonies are paler, finely granular, and irregularly shaped; causes bubbles in both gelatine stab and shake cultures; grows at 41.5°–42° C., and in decidedly acid media; in bouillon a diffused cloudiness and alkaline reaction; no indol; upon potato a moist, thin, gray membrane; coagulates blue milk in five days; acid reaction; ferments both milk sugar and grape sugar bouillon, with acid reaction, and CO_2 and H.

Bacillus i (belongs to the Colon group. Red colony).—A short rod; rounded ends; mostly in pairs; doubtful motility; does not liquefy gelatine; colonies in gelatine are brownish yellow, mostly round, sharp edges, granular, and darker in center; surface colonies are pale, larger, irregular, and with a nucleus; causes bubbles in both gelatine stab and shake cultures; grows at 41.5°–42° C. and in acid media; diffused cloudiness in bouillon; upon potato produces a scanty, shining, dirty-gray layer; coagulates blue milk with acid reaction in two days at 41.5° C.; ferments milk-sugar bouillon, with acid reaction, and production of CO_2 and H; ferments grape-sugar bouillon, with acid reaction, and production of H, but no CO_2.

Bacillus j (belongs to the Colon group. Red colony).—A short rod, with rounded ends; single and in pairs; slight motility; does not liquefy gelatine; colonies in gelatine are mostly spherical, amber colored, granular, with distinct edge; some are pale yellow, irregular in outline, with darker centers; causes bubbles in gelatine shake culture; grows at 41.5°–42° C., and in acid bouillon; upon potato a grayish, thin, moist membrane; coagulates blue litmus milk, with strong acid reaction, in two days, at 41.5° C.; ferments grape-sugar bouillon, with acid reaction, and production of CO_2 and H; ferments milk-sugar bouillon, with acid reaction, and production of CO_2 and H.

PILARCITOS WATER.

(Laguna Honda and Upper Russian Hill Districts.)

Fermenting organisms were isolated from 7 of the 10 samples of water collected from the Pilarcitos districts. Proteus was found in 5 samples, the colon bacillus in 2 samples. The samples were collected, for the most part, before the heavy rains.

Sample No. VII (December 4, 1895. From outside tap at 801 Sutton street. Laguna Honda District).—One hundred and twenty-six colonies to the cubic centimeter.

Bacillus k (belongs to the Proteus group. From gelatine.)—A short rod, single, in pairs, and short chains; actively motile, rapid progression, and undulating movements; grows well at room temperature and at 37° C., but not at 41.5° C.; liquefies gelatine all along stab; the liquefied gelatine has a characteristic appearance—a zone of cloudiness near the surface and an abundant precipitate at the bottom; young colonies in gelatine are brownish yellow, coarsely granular; liquefaction rapidly begins and spreads along the surface, with deposits in the center and granular zones arranged concentrically; in bouillon causes uniform cloudiness; cultures in gelatine and bouillon have a strong putrid odor and alkaline reaction; upon potato a moist, grayish-white, thin layer; coagulates blue litmus milk, with pink color in two days; moderate amount of indol; ferments milk-sugar bouillon, with alkaline reaction, and production of CO_2 and H; also ferments grape-sugar bouillon.

SAMPLE No. VIII (December 8, 1895. From tap at 914½ Ellis street. Laguna Honda District).

Bacillus l (belongs to the Proteus group. From gelatine).—A short bacillus, with rounded ends; actively motile; grows well at room temperature and at 37° C., but not at 41.5° C.; liquefies gelatine; young colonies in gelatine are granular, irregular in outline, and darker in the center; soon begin to liquefy and spread; a white sediment in the center of each colony, and granular rings arranged about the periphery; small processes, like cilia all around the edge; liquefies gelatine all along puncture; liquefaction gradually extends to sides, with a zone of cloudiness at surface, and an abundant white sediment at bottom; diffused cloudiness in bouillon, with thin zoögleal scum on surface; cultures in bouillon and gelatine have an alkaline reaction and sweetish, putrid odor; trace of indol; upon potato produces a yellow, moist layer; milk is coagulated in five days; ferments grape-sugar bouillon, with acid reaction; gas not determined.

SAMPLE IX (December 12, 1896. From Laguna Honda).—One hundred and six colonies to the cubic centimeter; ferments at room temperature, but does not ferment either grape-sugar or milk-sugar bouillon at 41.5°–42° C.

Bacillus m (belongs to the Proteus group. From gelatine).—A short rod, with rounded ends; mostly in pairs; very actively motile; liquefies gelatine and sends out processes; young colonies upon gelatine become granular and irregular in outline; soon liquefy and spread with processes about the edge; granular deposits in center and arranged concentrically toward periphery; stab cultures in gelatine have the characteristic appearance of Proteus vulgaris; in bouillon produces a uniform cloudiness, with zoögleal mass at the surface; cultures in bouillon and gelatine have an offensive, putrid odor and alkaline reaction; considerable indol; upon potato a dry, gray-white, thin layer; coagulates blue litmus milk, with acid reaction, in five days at room temperature; ferments 1 per cent grape-sugar bouillon, with acid reaction; gas not determined; ferments 1 per cent milk-sugar bouillon, with acid reaction; and production of H, but no CO_2.

Bacillus n (belongs to the Proteus group. From gelatine).—A short rod, with rounded ends; single and in pairs; motile, but not active; liquefies; grows well at room temperature; and at 37° C., but not at 41.5° C.; colonies in gelatine are pale yellowish, becoming darker and granular; some begin to liquefy and spread; in gelatine stab cultures liquefaction occurs all along the puncture, extending to the sides; liquefied gelatine has a zone of cloudiness at the surface, and a white precipitate at the bottom; alkaline reaction; diffused cloudiness and acid reaction in bouillon; both bouillon and gelatine cultures have a putrid odor; upon potato a thin, moist, scanty layer; coagulates milk, with acid reaction, in eight days; ferments both milk sugar and grape sugar bouillons, with acid reaction; gas not determined.

SAMPLE No. X (December 12, 1895. From Laguna Honda).—One hundred and eighty-four colonies to the cubic centimeter.

Bacillus o (belongs to the Proteus group. From gelatine).—A short rod; single pairs and short chains: rounded ends; actively motile; liquefies gelatine; colonies in gelatine are pale yellowish and granular, also round, dark brown with opaque centers; soon liquefies, with white deposit in center and granular zones toward periphery; spreading at edges; in gelatine stick culture liquefies like Proteus vulgaris; putrid odor and alkaline reaction; in bouillon, produces sweet, putrid odor, and acid reaction; no indol; upon potato a thin, moist, gray membrane; coagulates and decolorizes blue litmus milk in four days; ferments both milk sugar and grape sugar bouillons; acid reaction; gas not determined.

Bacillus p (belongs to the Proteus group. From gelatine).—A short rod; single and in pairs; very actively motile; liquefies gelatine; grows well at room temperature and at 37° C., but not at 41.5°–42° C.; colonies in gelatine have a yellowish-amber color, and mulberry shape; soon liquefy and spread; short processes about the edge; liquefies gelatine all along stab, with a zoögleal layer and cloudiness at the surface and sediment at bottom; also air bubbles along the sides; liquefies gelatine; has an alkaline reaction and putrefactive odor; diffused cloudiness in bouillon; no indol; upon potato scanty, glistening layer; causes a firm coagulum in blue milk in five days; ferments grape-sugar bouillon, with acid reaction; ferments milk-sugar bouillon, with acid reaction; the gas does not respond to tests for CO_2 or H.

SAMPLE No. XI (January 15, 1896. From tap at 412 Ashbury street. Laguna Honda District).—Four hundred and forty colonies to the cubic centimeter; does not ferment milk sugar or grape sugar bouillon at 41.5°–42° C.

Bacillus q (belongs to the Proteus group. From gelatine).—A short bacillus, with rounded ends; actively motile; liquefies gelatine; grows well at room temperature adn at 37° C., but not at 41.5° C. Colonies in gelatine are yellowish brown, granular, and round; become darker in center; short processes about edge; soon liquefy and spread; liquefies all along stab in gelatine; diffused cloudiness in bouillon; liquefies gelatine, and bouillon cultures are alkaline in reaction and have a putrefactive odor; no indol; upon potato scanty, moist, gray-white membrane; coagulates blue milk, with pink color, in five days; ferments grape-sugar bouillon, with acid reaction, and CO_2 and H; ferments milk-sugar bouillon, with acid reaction; gas does not answer to tests for CO_2 or H.

SAMPLE No. XII (February 7, 1896. From tap at 914½ Ellis street. Laguna Honda District.)—Three hundred and fifty colonies to the cubic centimeter; does not cause fermentation at 41.5°–42° C; not studied further.

SAMPLE No. XIII (December 12, 1895. From Upper Russian Hill Reservoir).—One hundred and forty-three colonies to the cubic centimeter.

Bacillus r (belongs to the Colon group).—A short rod; single, but mostly in pairs; rounded ends; very slight or no movements; does not liquefy gelatine; colonies on gelatine are pale hyaline, and larger ones are finely granular, darker in center, irregular in outline; uniform cloudiness in bouillon; causes bubbles in gelatine shake culture; no indol; upon potato produces a moist, yellow, raised membrane; grows well in acid bouillon; causes coagulation of blue litmus milk, with pink color, in fourteen days; ferments milk-sugar bouillon, with acid reaction; no CO_2; no H; ferments grape-sugar bouillon, with acid reaction; gas not determined.

SAMPLE No. XIV (December 21, 1895. From tap at 411 Greenwich street. Upper Russian Hill District).—Two hundred and thirty colonies to the cubic centimeter; ferments grape-sugar bouillon at 41.5°–42° C. Diligent search through many plates failed to isolate the fermenting cause.

SAMPLE No. XV (December 21, 1895. From tap at southwest corner Lombard and Dupont streets. Upper Russian Hill District).—One hundred and thirteen colonies to the cubic centimeter. Not studied further.

SAMPLE No. XVI (December 21, 1895. From tap at 1414 Dupont street. Upper Russian Hill District).

Bacillus s (belongs to the Colon group. Red colony).—A short rod, with rounded ends; single, mostly in pairs; motile; does not liquefy gelatine; young colonies in gelatine are spherical, hyaline, and refractive. Larger ones are yellowish, granular, and darker in center, irregular in outline; causes bubbles in gelatine shake culture; grows at 41.5°–42° C., and in decidedly acid media; diffused cloudiness in bouillon, with thin zoöglea on the surface; trace of indol; upon potato dry, thin, dirty-gray layer; blue litmus milk is coagulated with acid reaction in eleven days; ferments milk-sugar bouillon, with acid reaction; ferments grape-sugar bouillon, with acid reaction, and production of CO_2 and H.

Bacillus t (belongs to the Colon group. Red colony).—A short rod, with rounded ends; single and in pairs; actively motile; does not liquefy; grows at 41.5°–42° C.; colonies in gelatine plates are homogeneous and refractive, and spherical when small; become granular, dark in center and irregular in outline; in gelatine shake culture causes bubbles; in bouillon, a diffused cloudiness; trace of indol; upon potato a moist, grayish-white layer; coagulates blue milk in five days, with strong acid reaction; ferments grape-sugar bouillon, acid reaction, and CO_2 and H; ferments milk-sugar bouillon; acid reaction; CO_2 and H.

Bacillus u (belongs to the Colon group. Red colony).—A short rod; single and pairs; motile; not very active; does not liquefy; grows at 41.5°–42° C.; colonies on agar are irregular in outline, granular, darker in center, some spindle shaped; causes bubbles in gelatine shake culture; in bouillon a diffused cloudiness, with zoögleal membrane on the surface; potato dry, thin, gray-white layer; coagulates blue milk in six days; ferments grape-sugar bouillon, with acid reaction, and CO_2 and H; ferments milk-sugar bouillon with acid reaction; gas not determined.

Bacillus v (belongs to the Colon group. Red colony).—A short rod; single, in pairs and short chains; rounded ends; very actively motile; does not liquefy; grows at 41.5°–42° C.; colonies in agar are granular, irregular in outline; sharply defined edges; some are elongated and darker in center; causes bubbles in gelatine shake culture; diffused cloudiness in bouillon, and thin scum on the surface; no odor; trace of indol; upon potato a yellow, moist, and elevated layer; coagulates blue milk in six days; ferments grape-sugar bouillon, with acid reaction, and CO_2 and H.

CRYSTAL SPRINGS WATER.

(University Mound, Clarendon Heights, Lafayette Square, and Clay Hill Districts.)

Of the 17 samples examined from this district, fermenting organisms were found in only two, and in both instances, proteus. These results correspond to the fact that the land draining this basin is all owned and controlled by the company and kept free of habitation.

SAMPLE NO. XVII (December 12, 1895. From tap at 2324 Taylor street. University Mound District).—Four hundred and twenty-one colonies to the cubic centimeter; ferments at room temperature, but not at 41.5°–42° C.; nothing suspicious isolated.

SAMPLE NO. XVIII (December 21, 1895. From tap at 175 Minna street).—Eight hundred and ninety-four colonies to the cubic centimeter; ferments at room temperature, but does not ferment either milk-sugar or grape-sugar bouillon at 41.5°–42° C.

Bacillus w (belongs to the Proteus group. From gelatine).—A short rod; pairs and short chains; active motility; rapid, progressive, and undulatory movements; colonies in gelatine are pale and yellowish granular, liquefying, and spreading with short processes about the edge; liquefies gelatine all along stab, like Proteus vulgaris, alkaline reaction; uniform cloudiness in bouillon; cultures in gelatine and bouillon have a putrefactive odor; no indol; upon potato a thin, dry, grayish layer; coagulates milk with a pink color in six days; ferments grape-sugar bouillon, with very acid reaction; gas not determined.

SAMPLE NO. XIX (January 8, 1896. From tap at 705 Howard street. University Mound District).—One thousand six hundred and eighty colonies to the cubic centimeter; does not ferment milk-sugar bouillon at 41.5°–42° C.; no fermenting organisms isolated.

SAMPLE NO. XX (from tap at 9 Everett street. University Mound District. January 8, 1896).—One thousand eight hundred and sixty colonies to the cubic centimeter; not studied further.

SAMPLE NO. XXI (from 623 Natoma street. University Mound District. January 15, 1896).—Five hundred colonies to the cubic centimeter; ferments grape-sugar bouillon, but not milk-sugar bouillon at 41.5°–42° C.; many plates made and many organisms studied, but the fermenting cause was not isolated.

SAMPLE NO. XXII (from 577 Minna street. University Mound District. January 16, 1896).—One thousand two hundred and eighty colonies to the cubic centimeter; ferments grape-sugar bouillon, but not milk-sugar bouillon at 41.5°–42° C.; the fermenting cause not isolated.

SAMPLE NO. XXIII (January 29, 1896. From tap at 22½ Everett street. University Mound District).—Three hundred and fifty colonies to the cubic centimeter; ferments grape-sugar bouillon at 41.5°–42° C., but does not ferment milk-sugar bouillon at the same temperature.

Bacillus x (belongs to the Proteus group. Red colony).—A short bacillus; mostly in pairs; active motility; liquefies gelatine; grows at 41.5° C; colonies in gelatine are brownish, coarsely granular, liquefying, and spreading; younger colonies are paler and more irregular, with ciliated margins; soon liquefy and spread; liquefies gelatine all along puncture like Proteus vulgaris; decided odor; bouillon, uniform cloudiness; no indol; upon potato a moist, grayish, glistening membrane; coagulates blue milk; ferments milk-sugar bouillon, with acid reaction, and CO_2 and H; ferments grape-sugar bouillon, with acid reaction; gas not determined.

Bacillus y (belongs to the Proteus group. Red colony).—A short bacillus; motile; liquefies gelatine; grows at 41.5° C.; colonies upon gelatine are at first refractive and clear, become granular, striated, brownish yellow, and give off amœba-like processes; causes a uniform cloudiness in bouillon; liquefies gelatine all along puncture; alkaline reaction; no indol; coagulates blue litmus milk in four days; ferments milk-sugar bouillon, acid reaction, and CO_2 and H; ferments grape-sugar bouillon, with acid reaction; gas not determined.

SAMPLE NO. XXIV (February 2, 1896. From tap at 24 Hunt street. University Mound District).—Two thousand colonies to the cubic centimeter; does not ferment at 41.5°–42° C.

SAMPLE NO. XXV (February 2, 1896. From tap at South San Francisco primary school. University Mound District).—Ferments both grape-sugar and milk-sugar bouillon at 41.5°–42° C. Diligent search through many plates failed to isolate the fermenting cause.

SAMPLE NO. XXVI (February 7, 1896. From tap at 213 Tahama street. University Mound District).—Ferments both milk-sugar and grape-sugar bouillons at 41.5°–42° C. Fermenting cause not isolated.

SAMPLE No. XXVII (December 8, 1895. From outside tap at 1817 Jackson street. Lafayette Square and Clay Hill District).—Three hundred and thirteen colonies to the cubic centimeter. Not studied further.

SAMPLE No. XXVIII (December 21, 1895. From 1331 Washington street. Lafayette Square and Clay Hill District).—Five hundred and nine colonies to the cubic centimeter. Nothing suspicious.

SAMPLE No. XXIX (December 21, 1895. From 1334 Washington street. Lafayette Square and Clay Hill District).—One thousand three hundred and seventy-five colonies to the cubic centimeter. Nothing suspicious.

SAMPLE No. XXX (December 12, 1895. From 1226 Ashbury street. Clarendon Heights District).—One thousand eight hundred and seventy colonies to the cubic centimeter. Ferments neither milk-sugar nor grape-sugar bouillon at 41.5°–42° C.

SAMPLE No. XXXI (January 15, 1896. From tap at 121 Tremont street. Clarendon Heights District).—Does not ferment at 41.5°–42° C. Six hundred and fifty colonies to the cubic centimeter.

SAMPLE No. XXXII (January 15, 1896. From 741 Ashbury street. Clarendon Heights District).—Does not ferment either grape-sugar or milk-sugar bouillon at 41.50°–42° C.

SAMPLE No. XXXIII (January 15, 1896. From 117 Tremont street. Clarendon Heights District).—Eight hundred colonies to the cubic centimeter. Does not ferment either grape-sugar or milk-sugar bouillon at 41.5°–42° C.

VISITACION WATER.

The colon bacillus was found in 1 of the 3 samples of this water.

SAMPLE No. XXXIV (February 1, 1896. From tap at northwest corner Railroad and Twelfth avenue).—Five hundred and eighty-seven colonies to the cubic centimeter; ferments both milk-sugar and grape-sugar bouillon at 41.5°–42° C.; the fermenting cause not isolated. This water contains a bacillus which coagulates milk and produces red colonies on lactose litmus agar, and diffuses itself uniformly through the long arm of the fermentation tube, but does not cause fermentation. It grows well at 41.5°–42° C., and in other ways resembles bacterium coli communis.

SAMPLE No. XXXV (February 1, 1896. From tap at corner Thirteenth avenue and M street).—Ferments milk-sugar bouillon, but not grape-sugar bouillon, at 41.5°–42° C.

Bacillus z (belongs to the Colon group. Red colony).—A short bacillus, with rounded ends; in pairs and short rods; slight motility; does not liquefy; grows at 41.5° C.; colonies in gelatine are hyaline, refractive, and spherical when young; become granular, pale yellowish, and irregular in outline; causes bubbles in gelatine shake culture; grows in decidedly acid bouillon, causing diffused cloudiness; no indol; upon potato a moist, scanty, glistening membrane; coagulates blue milk, with acid reaction, in 5 days; ferments milk-sugar bouillon, with acid reaction, and CO_2 and H; ferments grape-sugar bouillon, with acid reaction, and CO_2 and H.

SAMPLE No. XXXVI (February 1, 1896. From 1182 Fifteenth avenue).—Two thousand colonies to the cubic centimeter; ferments milk-sugar bouillon at 41.5°–42° C., but does not ferment grape-sugar bouillon at the same temperature. Fermenting cause not isolated.

TABLE No. I.—*The mortality from typhoid fever at San Francisco, Cal., from 1870 to 1895.*

[Compiled from the reports of the Health Department.]

Years.	Deaths.	Population.	Per cent.	Years.	Deaths.	Population.	Per cent.
1869-70	69	†170,250	.00040	1882-83	137	‡250,000	.00055
1870-71	107	*172,750	.00062	1883-84	180	‡270,000	.00067
1871-72	104	*178,276	.00058	1884-85	138	‡270,000	.00051
1872-73	87	*188,323	.00046	1885-86	102	‡280,000	.00036
1873-74	80	*200,770	.00039	1886-87	145	‡300,000	.00048
1874-75	136	*230,132	.00059	1887-88	152	‡330,000	.00046
1875-76	161	*272,345	.00059	1888-89	138	‡330,000	.00041
1876-77	193	*300,000	.00064	1889-90	149	†300,000	.00049
1877-78	160	*300,000	.00053	1890-91	137	‡330,000	.00042
1878-79	121	*305,000	.00039	1891-92	113	‡330,000	.00034
1879-80	85	†234,520	.00036	1892-93	106	‡330,000	.00032
1880-81	87	†234,520	.00037	1893-94	114	‡330,000	.00035
1881-82	93	‡231,520	.00039	1894-95	123	‡330,000	.00037

*According to Sangley's City Directory. †United States Census. ‡Estimated by Health Department.

TABLE NO. II.—*Showing the relation of typhoid fever to rainfall at San Francisco, Cal.*

[*a*, Deaths from typhoid fever. *b*, Precipitation.]

Years.	July.		August.		September.		October.		November.		December.	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
1882-83	9	.00	11	.00	9	.00	17	2.66	23	4.18	22	2.02
1883-84	15	.00	20	.00	15	.42	11	1.48	28	1.60	17	.92
1884-85	14	.00	8	.04	13	.13	19	2.55	12	.26	10	7.08
1885-86	6	.06	12	.00	10	.11	13	.72	9	11.78	6	4.99
1886-87	12	.23	19	.06	13	.01	21	1.48	11	.84	13	2.07
1887-88	6	....	9	.01	9	.29	8	1.00	17	.99	25	3.34
1888-89	12	.01	10	.01	18	.98	13	.13	15	3.99	12	5.80
1889-90	....	....	....	....	....	....	....	....	....	....	....	....
1890-91	17	.02	13	.00	11	.31	21	.00	14	.00	10	3.25
1891-92	18	.10	16	.02	7	.77	8	.04	11	.56	12	5.62
1892-93	13	.00	14	.00	5	.02	13	1.65	11	3.91	7	5.08
1893-94	10	.02	11	.00	10	.21	9	.16	16	4.18	10	2.25
1894-95	8	.00	13	.00	12	1.05	9	1.73	10	.88	20	9.01

Years.	January.		February.		March.		April.		May.		June.	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
1882-83	10	1.92	6	1.04	7	1.04	10	2.64	6	2.52	7	.01
1883-84	20	3.94	11	6.65	14	8.24	10	6.33	9	.23	10	2.57
1884-85	13	2.53	15	.30	9	1.01	10	3.17	10	.04	5	.19
1885-86	5	7.42	9	.24	7	2.07	12	5.28	7	.37	6	.01
1886-87	13	1.90	9	9.24	9	.84	6	....	11	.06	....	.07
1887-88	23	6.81	8	.94	6	3.60	13	.11	12	.38	16	.27
1888-89	6	1.28	10	.72	8	7.78	13	.96	12	2.17	9	.03
1889-90	....	....	....	....	....	....	....	....	....	....	....	....
1890-91	13	.98	6	7.26	10	1.96	5	2.44	9	1.25	8	.11
1891-92	8	2.42	6	2.90	8	2.85	4	1.39	4	1.86	1	1.00
1892-93	4	3.08	5	2.75	3	4.08	4	10.30	3	.15	12	.03
1893-94	11	5.99	7	2.69	5	.60	5	.50	9	1.31	6	.56
1894-95	14	6.99	11	2.31	4	1.89	6	1.24	5	.60	11	.00

M. J. ROSENAU,
Passed Assistant Surgeon, U. S. M. H. S.

[Reports to the Supervising Surgeon-General United States Marine-Hospital Service.]

Two smallpox cases in Pensacola, Fla.

JACKSONVILLE, FLA., *March 31, 1896.*

SIR: You are hereby notified of the occurrence of a case of smallpox in Pensacola, Escambia County, Fla., on March 16, in the person of John Wilson, a negro, aged 32, who died of said disease on the following Saturday. All precautions observed. No further cases reported.

Yours, truly,
W. B. HENDERSON,
President State Board of Health.

PENSACOLA, FLA., *April 7, 1896.*

SIR: I have the honor to inform you of a second case of smallpox that has made its appearance in this city, and has been reported to the board of health by Drs. Herron and Anderson. The case has been sent to the pesthouse, and the house will be fumigated and effects of patient destroyed. The first case reported to you died.

Respectfully, yours,
J. WHITING HARGIS,
Acting Assistant Surgeon, U. S. M. H. S.